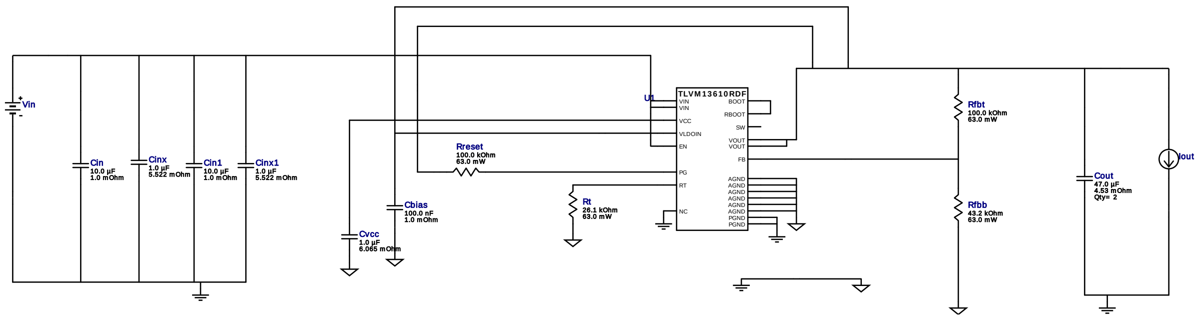
VinMin = 4.0V
VinMax = 16.0V
Vout = 3.3V
Iout = 2.0A

Device = TLVM13610RDFR
Topology = Buck
Created = 2024-09-08 15:37:18.862
BOM Cost = $4.88
BOM Count = 14
Total Pd = 0.2W

WEBENCH ® Design Report

Design : 3 TLVM13610RDFR
TLVM13610RDFR 4V-16V to 3.30V @ 2A



Design Alerts

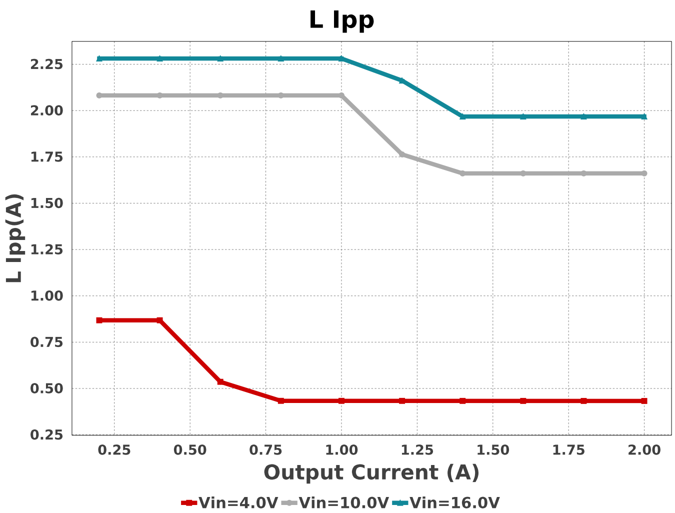
Component Selection Information

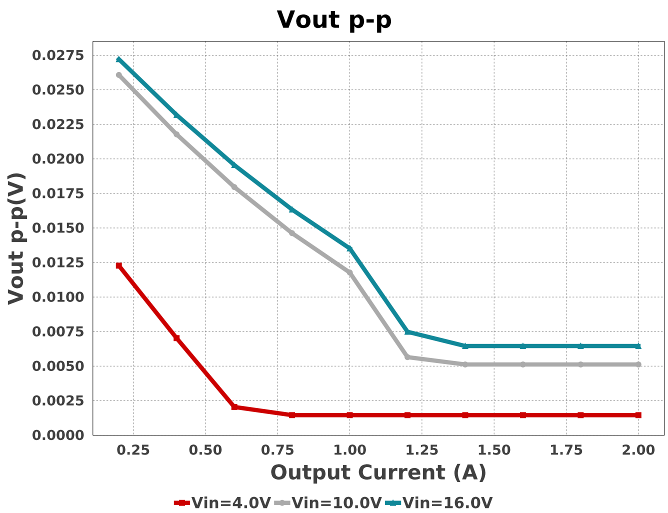
This device can work in steady state at Vin = 3V. However, needs a minimum of 3.6V during start up. See datasheet for details.

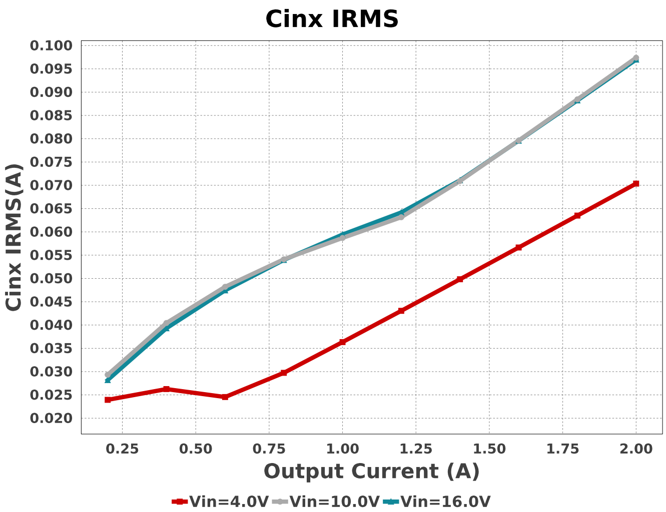
Electrical BOM

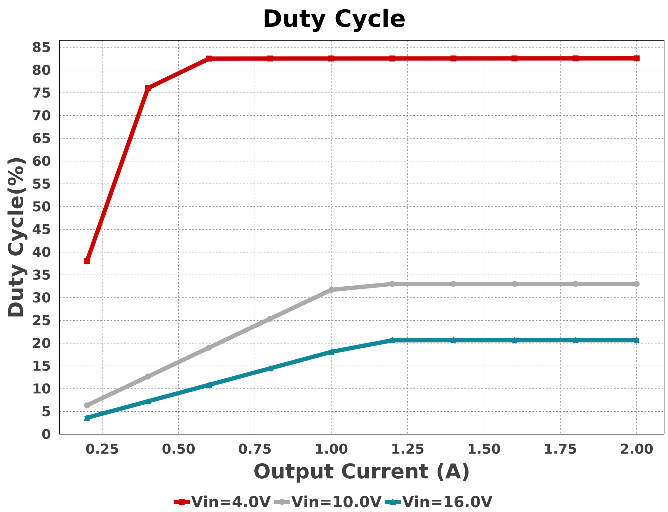
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbias	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cboot	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cin	MuRata	GRM32ER71H106KA12L Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 6.0 A	1	$0.47	1210_270 15 mm^2
Cin1	MuRata	GRM32ER71H106KA12L Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 6.0 A	1	$0.47	1210_270 15 mm^2
Cinx	TDK	C1608X5R1H105K080AB Series= X5R	Cap= 1.0 uF ESR= 5.522 mOhm VDC= 50.0 V IRMS= 2.2162 A	1	$0.03	0603 5 mm^2
Cinx1	TDK	C1608X5R1H105K080AB Series= X5R	Cap= 1.0 uF ESR= 5.522 mOhm VDC= 50.0 V IRMS= 2.2162 A	1	$0.03	0603 5 mm^2
Cout	TDK	C4532X5R1A476M280KA Series= X5R	Cap= 47.0 uF ESR= 4.53 mOhm VDC= 10.0 V IRMS= 3.6038 A	2	$0.43	1812_320 23 mm^2
Cvcc	MuRata	GRM188R60J105KA01D Series= X5R	Cap= 1.0 uF ESR= 6.065 mOhm VDC= 6.3 V IRMS= 1.36934 A	1	$0.01	0603 5 mm^2
Rfbb	Vishay-Dale	CRCW040243K2FKED Series= CRCW..e3	Res= 43.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbt	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rreset	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rt	Vishay-Dale	CRCW040226K1FKED Series= CRCW..e3	Res= 26.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TLVM13610RDFR	Switcher	1	$2.95	RPH0016A 25 mm^2

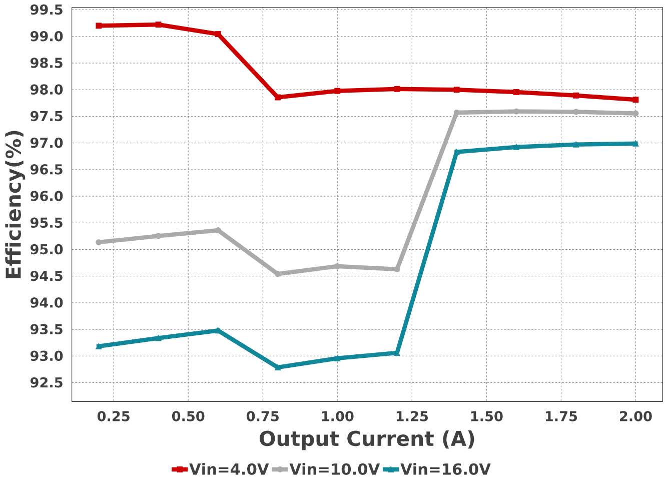




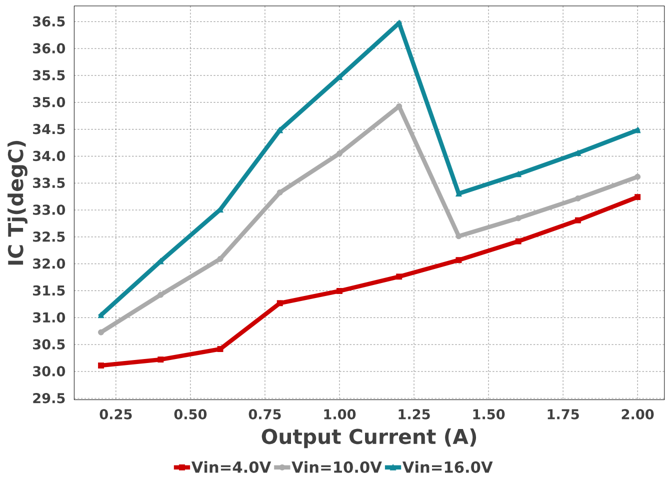




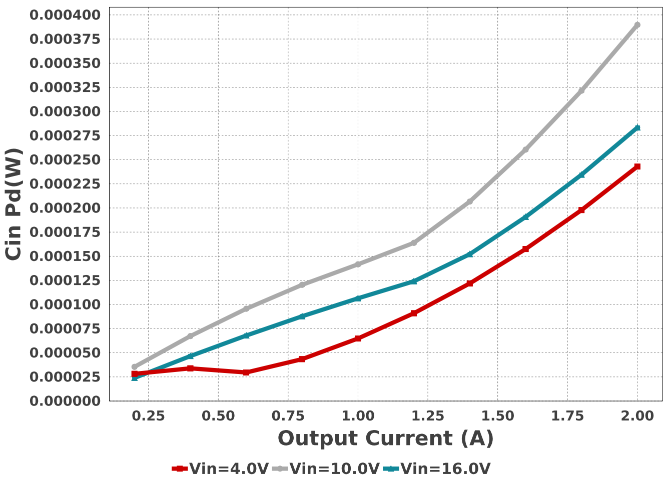
Efficiency



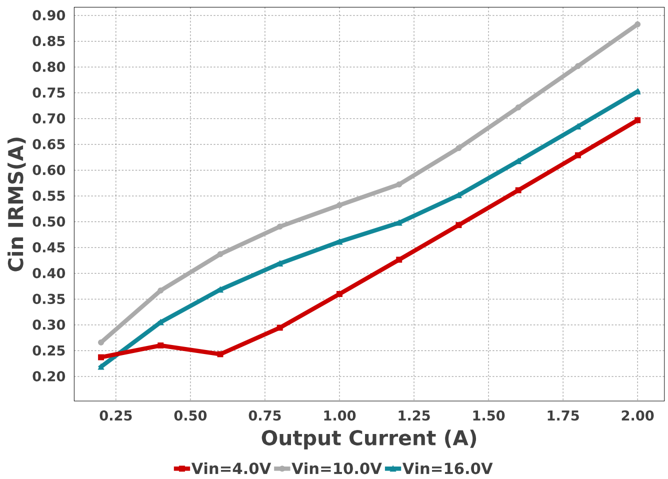
IC Tj



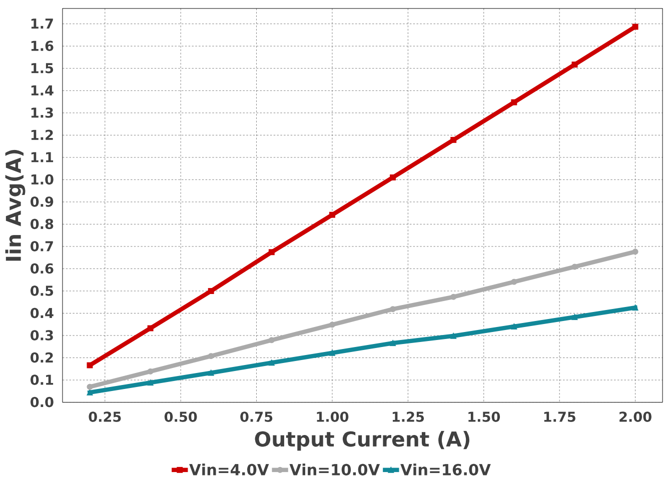
Cin Pd



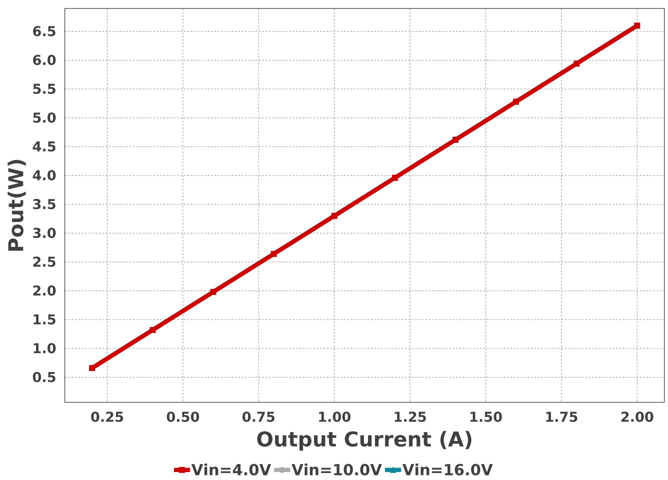
Cin IRMS

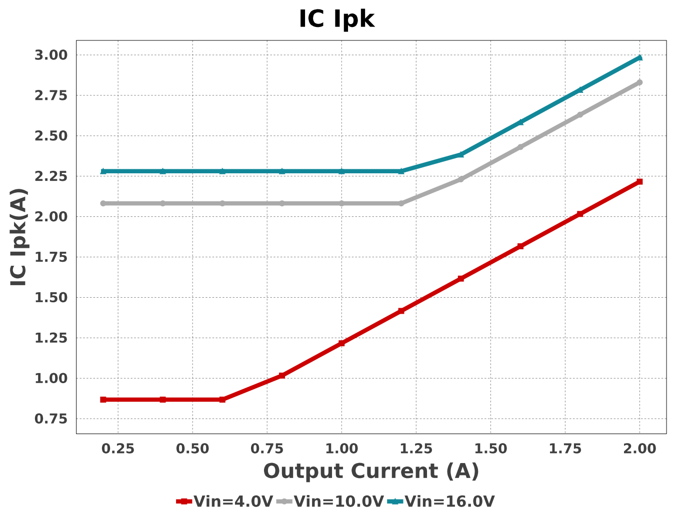


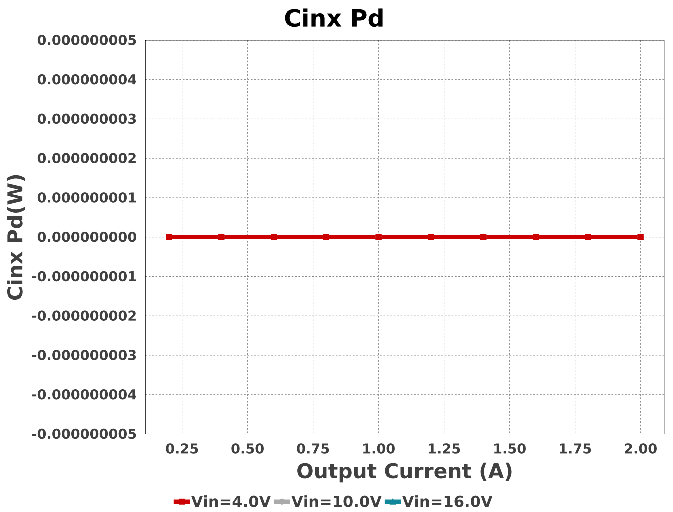
Iin Avg

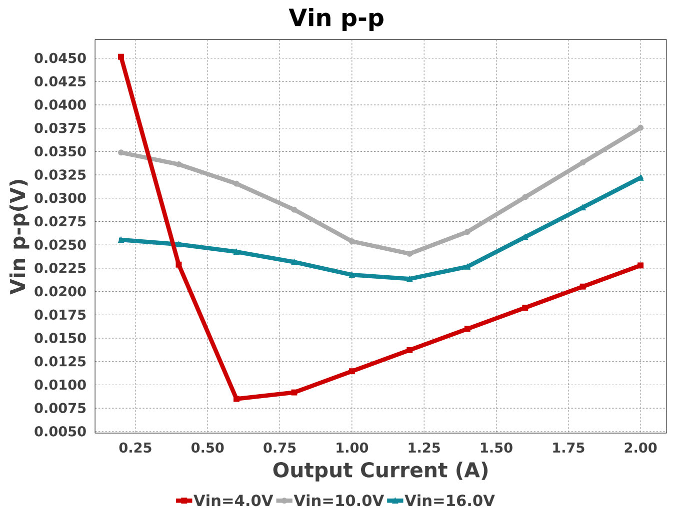


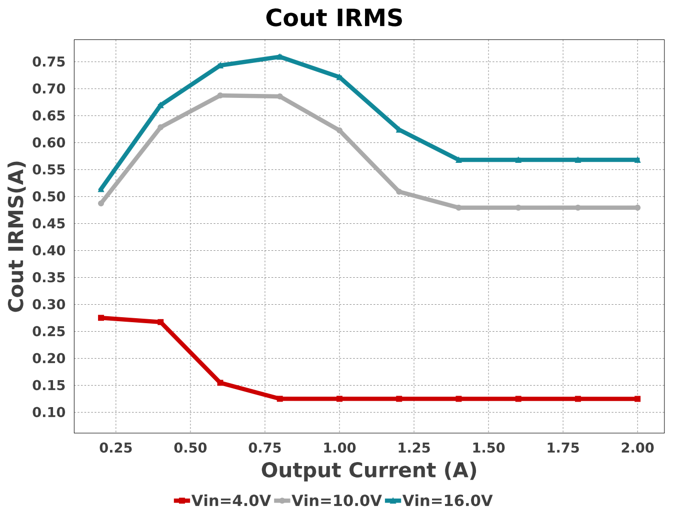
Pout

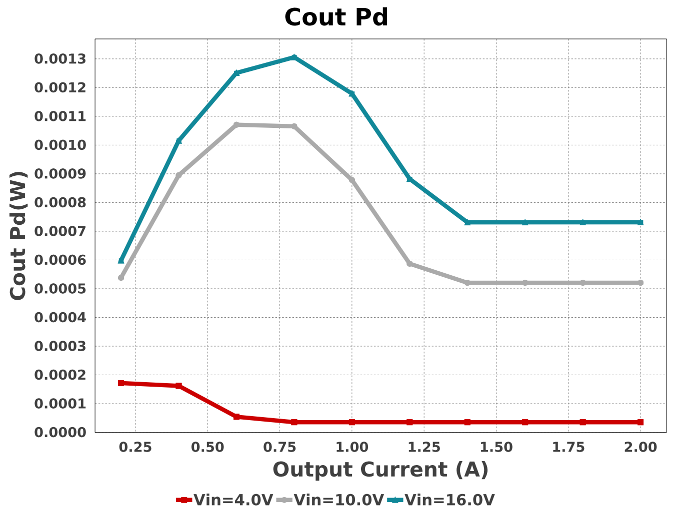


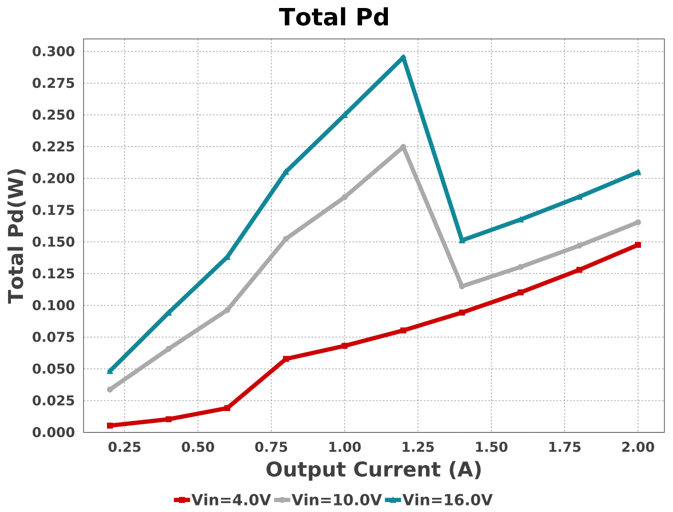

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=4.0V Vin=10.0V Vin=16.0V

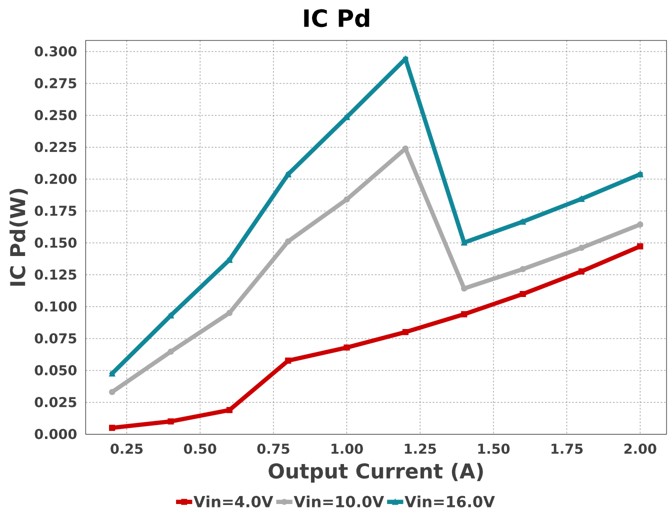

Cinx Pd
Cinx Pd(W)
Output Current (A)
Vin=4.0V Vin=10.0V Vin=16.0V

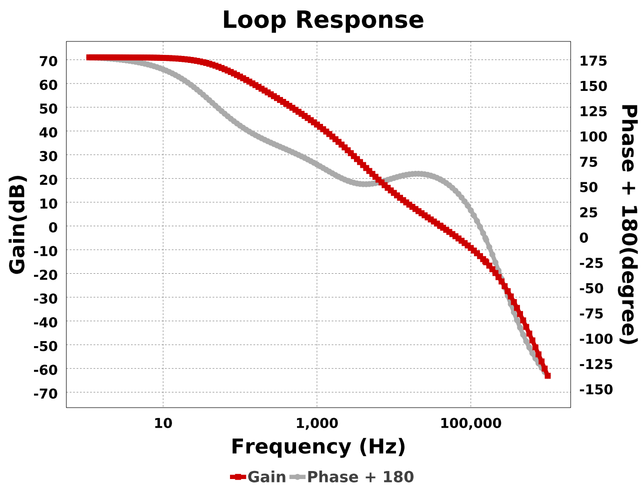

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=4.0V Vin=10.0V Vin=16.0V

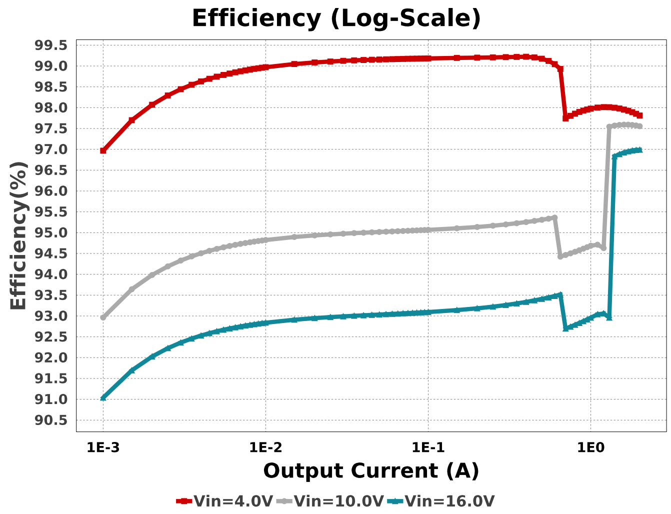

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=4.0V Vin=10.0V Vin=16.0V


Cout Pd
Cout Pd(W)
Output Current (A)
Vin=4.0V Vin=10.0V Vin=16.0V


Total Pd
Total Pd(W)
Output Current (A)
Vin=4.0V Vin=10.0V Vin=16.0V







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	752.739 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	283.31 µW	Capacitor	Input capacitor power dissipation
3.	Cinx IRMS	96.982 mA	Capacitor	Bulk capacitor RMS ripple current
4.	Cinx Pd	0.0 W	Capacitor	Bulk capacitor power dissipation
5.	Cout IRMS	568.171 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	731.18 µW	Capacitor	Output capacitor power dissipation
7.	IC Ipk	2.984 A	IC	Peak switch current in IC
8.	IC Pd	203.83 mW	IC	IC power dissipation
9.	IC Tj	34.484 degC	IC	IC junction temperature
10.	ICThetaJA Effective	22.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
11.	Iin Avg	425.31 mA	IC	Average input current
12.	Cin Pd	283.31 µW	Power	Input capacitor power dissipation
13.	Cinx Pd	0.0 W	Power	Bulk capacitor power dissipation
14.	Cout Pd	731.18 µW	Power	Output capacitor power dissipation
15.	IC Pd	203.83 mW	Power	IC power dissipation
16.	Total Pd	204.897 mW	Power	Total Power Dissipation
17.	BOM Count	14	System Information	Total Design BOM count
18.	Cross Freq	40.434 kHz	System Information	Bode plot crossover frequency
19.	Duty Cycle	20.647 %	System Information	Duty cycle
20.	Efficiency	96.989 %	System Information	Steady state efficiency
21.	FootPrint	132.0 mm^2	System Information	Total Foot Print Area of BOM components
22.	Frequency	605.494 kHz	System Information	Switching frequency
23.	Gain Marg	-14.876 dB	System Information	Bode Plot Gain Margin
24.	Iout	2.0 A	System Information	Iout operating point

#	Name	Value	Category	Description
25.	L Ipp	1.968 A	System Information	Peak-to-peak inductor ripple current
26.	Low Freq Gain	71.012 dB	System Information	Gain at 1Hz
27.	Mode	CCM	System Information	Conduction Mode
28.	Phase Marg	57.652 deg	System Information	Bode Plot Phase Margin
29.	Pout	6.6 W	System Information	Total output power
30.	Total BOM	$4.88	System Information	Total BOM Cost
31.	Vin	16.0 V	System Information	Vin operating point
32.	Vin p-p	32.192 mV	System Information	Peak-to-peak input voltage
33.	Vout	3.3 V	System Information	Operational Output Voltage
34.	Vout Actual	3.315 V	System Information	Vout Actual calculated based on selected voltage divider resistors
35.	Vout Tolerance	2.425 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
36.	Vout p-p	6.456 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	16.0	Maximum input voltage
VinMin	4.0	Minimum input voltage
Vout	3.3	Output Voltage
base_pn	TLVM13610	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature

WEBENCH® Assembly

Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of Cin and Cout, and the inductance and DC resistance of L1 before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

Soldering Component to Board

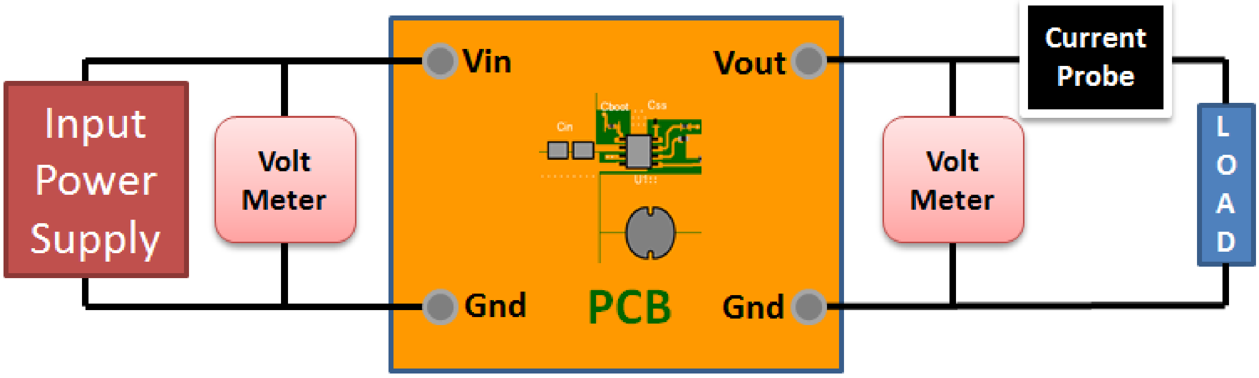
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab town to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 4.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to Vin and GND. Connect a digital volt meter and a load if needed to set the minimum Iout of the design from Vout and GND. Turn on the input supply and slowly turn up the current limit on the input supply. If the voltage starts to rise on the input supply continue increasing the input supply current limit while watching the output voltage. If the current increases on the input supply, but the voltage remains near zero, then there may be a short or a component misplaced on the board. Power down the board and visually inspect for solder bridges and recheck the diode and capacitor polarities. Once the power supply circuit is operational then more extensive testing may include full load testing, transient load and line tests to compare with simulation results.

Load Testing

The setup is the same as the initial startup, except that an additional digital voltmeter is connected between Vin and GND, a load is connected between Vout and GND and a current meter is connected in series between Vout and the load. The load must be able to handle at least rated output power + 50% (7.5 watts for this design). Ideally the load is supplied in the form of a variable load test unit. It can also be done in the form of suitably large power resistors. When using an oscilloscope to measure waveforms on the prototype board, the ground leads of the oscilloscope probes should be as short as possible and the area of the loop formed by the ground lead should be kept to a minimum. This will help reduce ground lead inductance and eliminate EMI noise that is not actually present in the circuit.



Design Assistance

1. The TLVM13610 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. This device can work in steady state at Vin = 3V. However, needs a minimum of 3.6V during start up. See datasheet for details The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application

2. Master key : 27AFC3A06A218B6F8EA41ED3B4C0DDB7[v1]

3. **TLVM13610** Product Folder : http://www.ti.com/product/TLVM13610 : contains the data sheet and other resources.

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